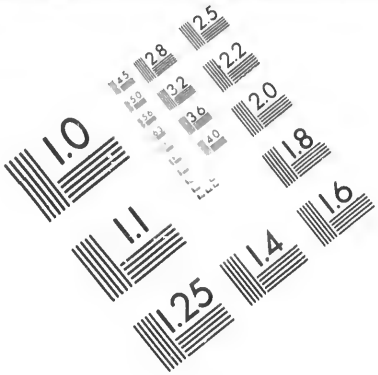

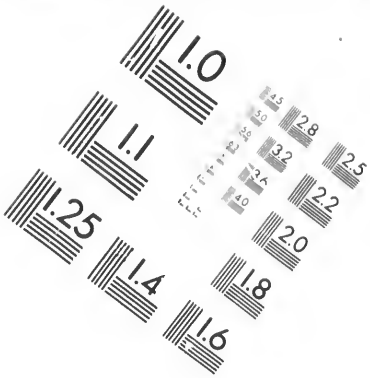

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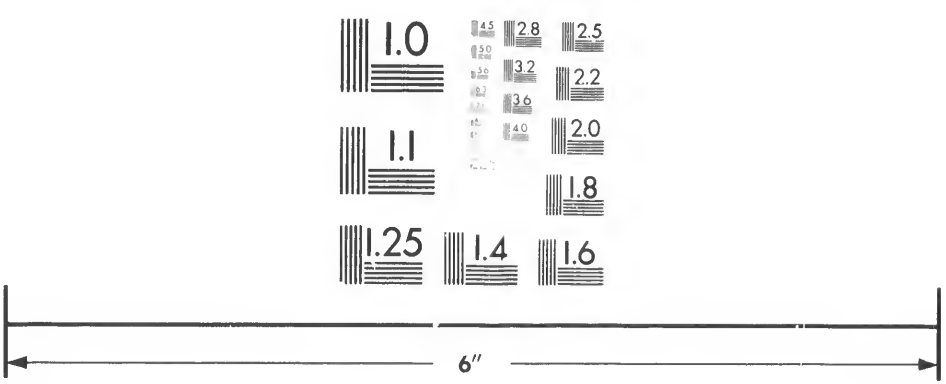

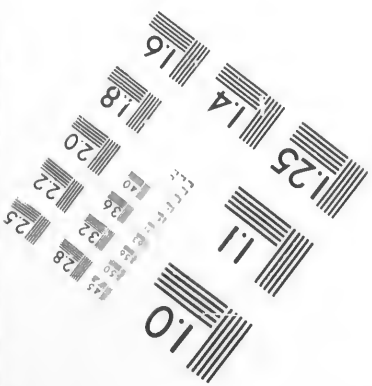

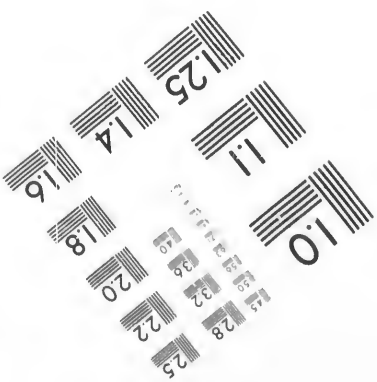

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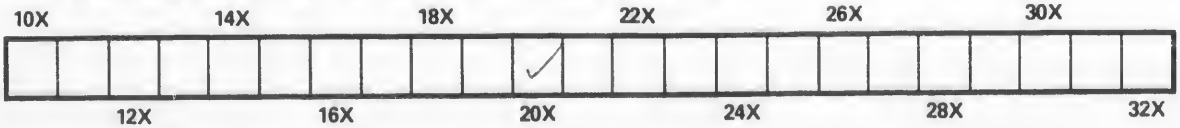

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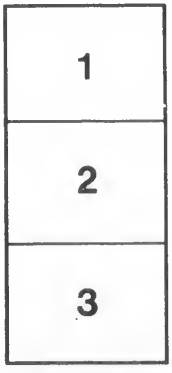

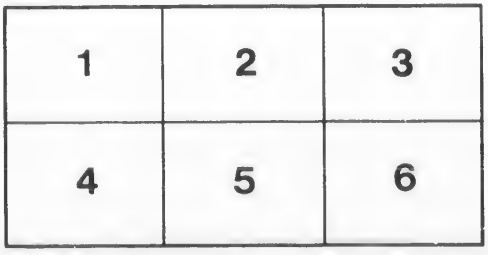

REPORT

...ON THE,,

MAIN SEWERAGE

...OF THE...

CITY OF OTTAWA

...BY...

RUDOLPH HERING,

Hydraulic and Sanitary Engineer,

NEW YORK.

May, 1897.

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MAIN SEWERAGE

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NEW YORK, MAY 31, 1897.

The Main Drainage Committee, Ottawa, Ont.,

C. Berkeley Powell, Esq., Chairman.

GENTLEMEN,—

In accordance with the action of Council on February 1st, 1897, and a request from your Chairman, I visited your city, February 15th to 19th, for the purpose of making an examination of the territory with a view to giving you an opinion as to the best method of sewerage and drainage for the undrained portions of the city.

Two plans had already been presented for the same purpose; one prepared by your City Engineer, Mr. Robert Surtees, supplemented by Mr. E. H. Keating, City Engineer of Toronto, and the other by Messrs. Keefer & Davy.

Both plans had in turn been submitted to the voters and were defeated. The reasons for voting down these plans, as I was given to understand, were that the first one appeared to be too expensive, and that the second discharged a large proportion of the sewage into the tail-race of the waterworks, from which discharge subsequent trouble was anticipated.

The instructions I received from your Chairman were to the effect that the city desired to know which of these plans, or which other plan, was the best one and the cheapest one, in my opinion, to properly drain the undrained portions of Ottawa. The undrained part of the city consists of 1733 acres, entirely unprovided for, and 266 acres imperfectly provided for, or, a total of 1999 acres.

During my visit to your city I examined the territory as fully as I

deemed necessary, in order to acquaint myself with its topographical features, and with such other conditions as it was necessary to consider. Since then I have been furnished with copies of the reports and plans previously made, and also with such other data as were necessary for my purpose.

The question before me could not be answered quickly. Although it was not necessary to furnish you with details regarding the proposed works, but only with a general plan and an opinion as to the main general features of a proper system, yet, in order to fix upon these features so as to meet the objectionable points, and at the same time to present a solution that accorded with the general desire of the public, required a considerable amount of study.

The problem in brief relates to a system of main sewers which will collect and remove both the sewage, or foul water, and the surface water from those portions of the city of Ottawa mentioned above for which in these respects public works are not yet provided. It further relates to a proper disposal of this sewage so that it can neither cause a nuisance to the citizens nor be objectionable to them in any other way.

To ascertain the best method of collection it was necessary first to determine where and how the sewage could be safely and economically disposed of. I have therefore divided the report into three main divisions, treating, first, of the final disposal of the sewage; secondly, of the collection of the sewage, and thirdly, stating the estimates of cost and conclusions.

I.

FINAL DISPOSAL OF THE SEWAGE.

There are several methods of finally disposing of the foul waters collected in a large community. The best at present known is a purification of the sewage by filtration through porous soil at a slow rate, varying from ½inch to 2 inches vertically, per day, by which the organic

matter is almost wholly oxidized and the bacteria are practically all removed. Such a method has been in use for many years, particularly in English towns, and gives entire satisfaction. It is necessary, however, to have a sufficient area of suitable soil, suitably prepared by leveling, subdraining, and a subdivision into beds, upon which the sewage is distributed intermittently by especially constructed carriers. In other words this process requires a certain amount of land and entails an annual expense.

Where such land is not obtainable and it is nevertheless required to remove the decomposable organic matter from the sewage, another method has been developed, likewise mainly in England, by which the suspended organic matter is precipitated from the sewage in tanks specially built for the purpose. The precipitation is produced by a mixture with certain chemicals, such as lime, sulphate of alumina of salts of iron. These chemicals, cause a coagulation of the organic matter, and, as the resulting flocculent substance produced thereby settles to the bottom of the tanks, it carries with it the other suspended matters not coagulated and also most of the bacteria of the sewage. The supernatant liquid is allowed to flow off into a water course, freed, as experience demonstrates, of about one-half of its organic matter, but clear in appearance. The deposited matter, called sludge, is then taken from the tanks and its water removed by the pressure. The pressed sludge is sometimes sold as manure of an inferior quality, but generally it is wasted, and dumped upon suitable ground, or burned.

A third method of disposing of the sewage of large cities is to discharge it into a body of water, of sufficient volume or size to thoroughly dilute it. The oxygen contained in the river or lake water gradually oxidizes and thus obliterates the objectionable organic matter in the sewage. This oxidation, under the conditions furnished by a discharge into a lake or river is a slower process than the oxidation in porous soil, and the practical result is that only in very long or large rivers or lakes will such an obliteration of the sewage take place. It has been correctly

stated in England that no river in that country is large enough to completely oxidize sewage matter discharged into it.

The advantage to be expected from a discharge into a river is a thorough dilution, which causes slow decomposition rather than putrefaction, and therefore renders the sewage at once inoffensive. *Parri passu* there is a gradual reduction in the number of sewage bacteria, and probably also of pathogenic bacteria. Little is known regarding the length of time the latter will continue to exist in running water of a given composition. But it is known that those bacteria which are supposed to be the cause of typhoid fever and diarrhoeal and similar diseases will not all perish for several weeks.

Of the above three methods of sewage disposal the latter is, in the present case, by far the least expensive. It necessitates merely the construction of sewers with outfalls leading out into the current of the river. The disposal of the sewage by irrigation or filtration would require a large area of land below the city adapted for the purpose, and of the existence of which I have no information. But it is evident that the cost of conducting the sewage to a point below the city, preparing a large area of land for its treatment, and then paying the annual expenses for such treatment, would be quite considerable

A system of chemical treatment at a point below the city would also be expensive. Besides the cost of building the large tanks and the necessary pumps and sludge-pressing machinery, the cost of operation, which in England is found to be about 25 cents per annum per head of population, would in your city reach a still higher figure.

A disposal of the sewage of your city into the Ottawa river is an entirely harmless method. It can not be positively demonstrated at the present time that such a disposal will contribute serious injury to any city below, where a water supply is taken from the same. It is a fact that disease bacteria get into drinking water from other causes than by the introduction of sewage. If, therefore, the water is to be free from

danger it should for this reason alone be subjected to a special purification, as done in many cities of Europe immediately before it is delivered into the distribution mains.

The question to be examined in this case is therefore one of creating a nuisance, or of the river becoming objectionable to the residents along the shores.

There is sufficient experience now available so that we can state with a high degree of certainty what effects will be produced by the discharge of a given amount of sewage into a given stream. An extensive investigation on this subject was made over ten years ago in the City of Chicago, where it was found necessary to construct an expensive canal, costing about 25,000,000, for the purpose of receiving the sewage of that city, and of diluting it with lake water, so that it would not become offensive along its course, or subsequently in the Illinois River into which the canal water is discharged. It was found that under comparatively favorable conditions it required a flow of four cubic feet per second of lake water to properly dilute the sewage of 1,000 persons. Upon this assumption the canal has recently been constructed. Since then other investigations have been made, and it has been found by examinations, gaugings and analyses, that for smaller streams a greater dilution is advisable. Altogether, the range which at present is considered to be the doubtful ground is a dilution of the sewage with running water, having a flow of from two and a half to seven cubic feet per second for each 1,000 persons contributing sewage. A less dilution than two and a half cubic feet is sure to cause a nuisance ; a greater dilution than seven cubic feet is not known ever to have been objectionable.

If we apply these facts, which cover experience both in the United States and Europe to the case before us, we find as follows :

A gauging of the Ottawa river was made some years ago at Grenville, about sixty miles below Ottawa and it was found that the low

water flow was 35,000 cubic feet per second. Another gauging was made about 70 miles above the city, at Portage Dufort, and the low water flow was there found to be 32,000 cubic feet per second. If we assume, endeavoring to be on the safe side, the extreme low water flow in front of the city of Ottawa at 30,000 cubic feet per second, and adopting the highest figure for the dilution of the sewage, that has anywhere been found advisable ; in other words, if we assume that it requires a flow of seven cubic feet per second to dilute the sewage of each 1,000 persons, then the minimum flow of the Ottawa river during the fall and winter months would be sufficient to receive the sewage of 5,000,000 persons before it would cause a nuisance.

Stating this fact in another way, we find that, assuming the population of Ottawa to be 100,000, (it is at present about 50,000), the dilution would be 300 cubic feet per second for each 1,000 persons, or 25,920 cubic feet per day (161,536 imperial gallons) for each person. This indicates that the dilution would be over forty times as great as has elsewhere been found necessary in the most unfavorable case.

It is known that more sewage can be properly discharged into a river having a low temperature than where its temperature, for instance in summer, is high. This fact still further favors a discharge into the Ottawa river, the temperature of which, even in summer, is quite low. It is said never to reach 60°.

On the other hand, there are some unfavorable features due to the configuration of the river bed in front of the city. While a strong current exists in some parts of it, there are other parts where, owing to the irregularity of the shore line, we find slack water and even eddies. It will be evident that where there is no constant downward current, but slack water and eddies instead, suspended matter will be deposited. Thus, we find extensive deposits of sawdust and waste from the mills at places where the current has been checked and its velocity is insufficient to carry them off.

We can therefore draw the conclusion that if the Ottawa river is to receive the sewage, the outlets must be in the current and not near the shore, nor at points where the sewage can get into slack water or eddies.

A few sewers, situated along the shore of the river between Bay and Bank streets now have their outlets at the water's edge. This condition necessarily allows deposits to take place and must therefore occasionally cause offense. The effects of discharging sewage out into the current must not be judged by the effect when it is discharged near the shore.

In order to deliver sewage into a stream so that it will remain in the current, it is necessary to carry the pipes sufficiently far out on the bed of the river and to let the sewage escape so that there is a large body of water flowing between the outlet and the shore. Then the sewage will at once not only obtain a fair degree of dilution, but it will also be prevented from approaching the shore.

These results presuppose a previous screening out of large particles of suspended matter which would otherwise rise to the surface of the river, and, while floating upon it, be driven to the shore by the wind. Before the sewage is dropped into the submerged outlet channel it must be screened and the screenings especially removed. Their quantity will be found to be quite small. In the city of Boston it amounts to only a cart-load a day at the southern sewage pumping station. In the city of Ottawa it might not be more than a couple of wheelbarrow loads a day and therefore would be insignificant, and the cost hardly worth mentioning.

From the foregoing considerations, I am of the opinion that a discharge into the Ottawa river, if it is properly arranged, cannot possibly be objectionable in front of the city, and I have no hesitation in recommending this method of disposal.

The next question to be decided is at what points along the river such a discharge will be most economical and most suitable.

Beginning at the Chaudiere Falls there are six points which I have specially considered :

a. A large amount of water (minimum 1719 cubic feet sec.) is discharged into the river from what is known as the Buchanan channel A suitable point of discharge is therefore into the Ottawa River just *above* the outlet of the Buchanan channel. The water from the latter will then pass down the river between the shore and the sewage, and will prevent it, even in its highly diluted condition, from approaching the southern shore. The further out into the channel the outfall pipe is carried, the more rapidly the dilution will be accomplished and the quicker will the sewage disappear. If discharged at the bottom of the river it would in fact never be seen.

b. While I cannot discover any good reason why a discharge of the sewage into the tail-race from the water works can ever cause a nuisance on account of the great dilution which will be given to it, there are, nevertheless, circumstances which prevent that channel from being considered as the best place of discharge, although it will require the least outlay of money. The sewage at this point would enter a current (minimum 400 cubic feet per second) flowing along the southern shore of the river in front of the city. I understand, further, that there is a possibility of a dam being erected at the foot of the tail race, for the purposes of navigation, in the interest of the owners of the channel. In such a case there would be an objection to a sewage discharge into it, because the resulting slack water would cause a deposit of fine sewage matter. Along the southern shore, below the outlet of the tail-race, there are already several areas of slack water and eddies where the same results can be expected. The sawdust deposits give evidence to substantiate this conclusion. The section of the tail-race constantly increases in depth and width, causing a corresponding reduction of the velocity, which fact also conduces to deposits. Therefore, I have not further considered a discharge of sewage into the tail-race.

c. The next location considered is at the outfall of the present

main sewer. It is situated at the western side of the mouth of the Rideau river, and is a very good location, although the sewage should not be discharged at the shore, but by means of a submerged pipe reaching out towards the channel. The reason why this point is a good one lies in the fact that the sewage will be carried away between the body of water discharged by the Rideau river and the body of the Ottawa river, which must therefore prevent it from ever reaching the shores below the city.

d. Another outfall which has received consideration is located on the eastern side of the mouth of the Rideau river. It has been suggested in all the previous reports, and while, for reasons stated above, it is not as good a point as the one on the western side of the Rideau river, it can nevertheless be made quite satisfactory, if the outlet pipe is carried a little further towards the current of the river than in the other case. I can see no objection to this outfall if the above precaution is taken, and the sewage is discharged near the channel and at the bottom of the river, thus preventing it from reaching the shore of the proposed park below.

e. An outfall has been suggested at a point of rocks located in the proposed Park, where the water is deep and where there is said to be a constant and strong current. No objection can be raised against this point, other than the expense of conducting the sewage to it, if it is discharged away from the shore.

f. Finally, there has been suggested an outfall at the shore of the river below McKay's Lake, called the Rockcliffe Outfall. If the sewage is carried into the stream by means of a submerged pipe, this outfall would also be perfectly satisfactory. Its selection would depend partly on its cost and partly on its usefulness. It must be admitted that the sewage leading to this outfall necessarily passes through much territory that at present has no need of sewerage.

It is therefore seen that five of the practicable outfalls that have

been examined, may be arranged so that none will cause any objectionable results whatever. Their preference should be decided upon a basis of cost. Sentimental reasons, it is true, do in some cases also influence a decision. If they are to govern in this case, it must be understood that the sentiment is to be paid for by a sum of money greater than that which necessity and propriety alone will demand.

Before definite recommendations as to the preferable outfalls can be made, the second main question, namely, that of the collection of the sewage, must be carefully considered.

II.

COLLECTION OF THE SEWAGE.

There are several methods according to which local sewerage systems are built to-day. One is to carry off the sewage and the rain water in the same channels; another is to separate the two, and to confine the sewerage system proper to the removal of fowl water alone, and the other, or drainage system, to the removal of rain-water alone.

The advantage of the latter or separate system, is found where the sewage must be pumped prior to disposal, or where it must be subjected to an artificial purification. In such instances it is necessary to reduce the quantity of sewage as much as possible, and then it will generally be less expensive to build a double system than a single one.

In your city neither of these conditions exists and therefore the combined system, such as you have adopted already, is the proper one. The undrained portions of the city therefore should likewise be sewered on the combined system, as recomended to you in previous reports.

The admission of rain-water into sewers requires that they be made large enough for the water from very heavy and sudden downfalls. As the cost of the sewers naturally increases with their size, it is very important that the amount of rain-fall they are to carry should be carefully considered.

OMITTED

GENTLEMEN,--

Herewith enclosed I beg to hand
use which Hull Council purposes to m
borrowed under By-Law No. 70, whic
the approval of the ratepayers on Mon
next.

The revenue has been estimated
existance and should largely increas
waterworks to these streets, through t
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The waterworks system will at
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The rate of interest has been fixed at
tures issued in April last and upon which
rable primium (107.90). You will the
proved position in which the City will b
expenditure.

Hoping that it will meet with your

.....
Chairman

I beg to hand you a statement of the purposes to make of the $53,500 to be No. 70, which will be submitted for payers on Monday, the 13th September

een estimated upon houses actually in argely increase with the extension of eets, through the erection of new build- f buildings already erected thereon.

ystem will at the same time be ~~natu-~~ materially oing away with dead ends or blow offs ource of weakness and loss.

as been fixed at 4½%. the same as on deben- and upon which the City received conside- You will therefore see the greatly im- the City will be placed by this proposed

neet with your approval.

R. V. Farley

Chairman of ~~Water~~ Works Committee.

Report on proposed Extensions at Syston

Transfer on ...

HULL • WATER

Report on proposed Extensions of System, sh
Interest on amounts

Ward.	Street.	From	To	Size of Main.	Hydrants	Services	Estimated Cost	To Estim Co
1	Brewery	End 10in. Main.	Front	10 inch		4	$ 1 575 00	
"	Philomen	Chelsea Road	Joshua	6 "		3	402 00	
"	Regina	" "		6 "	1	8	703 15	
"	Victoria	" "		6 "	2	5	940 00	
"	Joshua		Victoria	6 "	2	8	1 242 40	
"		Regina	"	6 "	2	5	605 00	$ 5 4
2	Wellington	Pump House	Brewery	15 "			3 000 00	3 0
"	Catherine	Chaudière	Autumn	5 "	1	10	1 080 80	
"	Ravine & Autumn	Wright	Ann	6 "	2	30	3 733 80	
"	Rock	Chaudière	Ivy	5 "	1	9	1 422 90	
"	Ivy and Ravine	Rock	Ends of Streets	5 & 3 "		12	738 10	
"	Woburn	Chaudiere	Near Ravine	5 "	2	23	2 003 70	
"	Chaudière	Catherine	So'n of Woburn	6 "	1	16	1 875 00	
"	Lane	Wall	Chaudiere	3 "		4	431 00	
"	Ann	Chaudiere	W'st of Autumn	6 "	2	25	1 830 00	
"	Chaudière	Charles	Rock	5 "		3	200 00	13 3
3	Wright	Bridge	Chaudiere	5 "		9	714 00	
"	Albert	Duke	Church	5 "		7	666 00	
"	Albert	Bridge	Chaudière	6 "	1	11	887 00	
"	Charles	"	"	6 "	1	15	1 208 85	
"	Chaudière	Philomon	To near Albert	3 "		5	344 70	3 8
3A	Bridge	Charles	Queen	6 "	2	39	3 089 50	
"	Church	"	Wall	6 "	1	33	1 744 80	
"	Wall	Duke	Hannah	6 "		3	291 75	
"	Ann	"	Bridge	6 "	1	13	1 372 80	
"	Hanna	Charles	Wall	6 "	1	20	1 365 65	
"	St. Florent	Queen	Adelaide	6 "	2	49	2 550 55	
"	St. Henri	End of Main	"	6 "	1	20	661 20	
"	St. Hyacinthe	Queen	"	6 "	3	57	3 167 46	
"	Ste. Etienne	St. Hyacinthe	Chaudière	3 "		10	224 80	
"	Chaudière	Queen	Adelaide	6 "	3	19	1 516 20	15 9
4	Alma	Victoria	Ottawa	5 "	1	24	2 465 65	
"	St. Joseph	Main	Britannia	6 "	1	12	1 100 80	
"	Ottawa	Britannia	Alma	5 "		18	1 325 00	4 8
5	Division	Albion	Kent	6 "	1	3	323 00	
"	Britannia	Division	St. Bernard	6 "	3	32	1 259 50	
"	Albion	"	"	6 "	2	28	1 179 50	
"	Kent	"	"	6 "	2	26	1 113 80	
"	St. Bernard	Kent	Britannia	6 "			380 50	
"	Marston	Boult	Stewart	6 "	1	7	369 00	
"	Stewart	Marston	Chamberlin	6 "		5	298 30	
"	Chamberlin	Stewart	Lorne	6 "	2	3	505 00	
"	Lorne	Chamberlin	Cartier	6 "	1	7	484 00	
"	Cartier	Lorne	Towards Creek	6 "	1	15	682 00	6 5
	Totals				47	554		$53

ATER • WORKS.

System, showing Estimated Cost, Revenue, and n amounts expended.

Estimated Cost	Total Estimated Cost.	Revenue	Total Revenue	Interest.	Total Int.	REMARKS
$ 1 575 00	.....	$ 32	.....	2 p c	.....	Vacant Lots included
402 00	.....	40	.....	10 p c	.....	" "
703 15	.....	68	.....	10 p c	.....	
940 00	.....	52	.....	6 p c	.....	" "
1 242 40	.....	108	.....	9 p c	.....	" "
605 00	$ 5 467 55	64	$ 364	10 p c	6¾ p c	
3 000 00	3 000 00	.....	.....	.....	.....	
1 080 80	.....	80	.....	8 p c	.....	
3 733 80	.....	250	.....	8 p c	.....	
1 422 90	.....	85	.....	6 p c	.....	
738 10	.....	96	.....	13 p c	.....	
2 003 70	.....	184	.....	10 p c	.....	
1 875 00	.....	128	.....	7 p c	.....	
431 00	.....	32	.....	8 p c	.....	
1 830 00	.....	200	.....	12 p c	.....	
200 00	13 315 30	24	1 079	12 p c	8 p c	
714 00	.....	72	.....	10 p c	.....	
666 00	.....	56	.....	9 p c	.....	
887 00	.....	88	.....	10 p c	.....	
1 208 85	.....	120	.....	10 p c	.....	
344 70	3 820 55	40	376	12 p c	10 p c	
3 089 50	.....	330	.....	11 p c	.....	
1 744 80	.....	264	.....	15 p c	.....	
291 75	.....	24	.....	8 p c	.....	
1 372 80	.....	104	.....	8 p c	.....	
1 365 65	.....	160	.....	12 p c	.....	
2 550 55	.....	392	.....	15 p c	.....	
661 20	.....	160	.....	25 p c	.....	
3 167 46	.....	456	.....	15 p c	.....	
224 80	.....	80	.....	36 p c	.....	
1 516 20	15 984 71	152	2 122	10 p c	13¼ p c	
2 465 65	.....	198	.....	8 p c	.....	
1 100 80	.....	100	.....	9 p c	.....	
1 325 00	4 891 45	144	442	10¾ p c	9 p c	
323 00	.....	24	.....	8 p c	.....	
1 259 50	.....	256	.....	20 p c	.....	
1 179 50	.....	224	.....	19 p c	.....	
1 113 80	.....	208	.....	19 p c	.....	
380 50	.....	.....	.....	.....	.....	
369 00	.....	56	.....	16 p c	.....	
298 30	.....	40	.....	15 p c	.....	
505 00	.....	24	.....	5 p c	.....	
484 00	.....	56	.....	12 p c	.....	
682 00	6 594 60	120	1 008	18 p c	15¼ p c	
.....	$53 074 16	.....	5 391	.....	10 p c	

FRANK A. HIBBARD,

ENGINEER.

In view of the experience gained elsewhere, the amount of rain-fall which was assumed to enter the main sewer in the first plan, is too small, as pointed out by Mr. E. H. Keating, The amount assumed for the main sewer by Messrs. Keefer & Davy was increased to about double.

While in my opinion the latter assumption is still insufficient to provide for the water which will eventually run off the city's territory during the heaviest rain-falls, I am yet ready to endorse the quantity recommended by Messrs. Keefer & Davy, as relieving the city for a number of years and until the surface becomes much more impervious than it is at present.

It should be understood that the amount of water reaching sewers from a given rain-fall depends largely upon the physical character of the ground upon which it falls. If this is porous a large proportion of the rain at once sinks into the ground. If it is covered by roof surfaces and improved pavements, then very little water will sink into the ground on such areas, but will run off rapidly, first into the gutters and then into sewers. In a well built-up city, therefore, it is necessary to provide for the removal of a much larger quantity of water from the same storm than would be necessary in a city where the streets are not yet paved and where the houses are not close together.

In the large cities of the United States provision is made for a greater quantity of water to enter the sewers than has been made in the plans prepared for your city. Judging from the data before me, the heaviest rain-falls are neither as great nor as frequent as in the United States, therefore the same necessity for conducting so large a quantity of water underground does not exist. Rain-falls of one inch in ten minutes occasionally occur in the eastern and southern portion of the United States. I have, however, a record of a rain-fall in your city of 0. 52 inches, as having fallen in ten minutes on August 17th, 1896. The water from such a rain-fall might be carried off at the present time without causing much trouble. But when the area of your city becomes more impervious, some of your streets would have to retain a good deal

of the water upon their surfaces for some time before it could be removed by the sewers.

From territory adjoining the larger water courses, the surface water should be allowed to run off into them over the surface or in special drains, in order to economize in the size of the sewers. Wherever practicable this has been so arranged. On the balance of the territory the quantity of storm water reaching the sewers has been determined by the formula:

$$Q = \sqrt[5]{\frac{S}{A}} \quad \text{in which}$$

Q = the quantity of storm water reaching the sewers, in cubic feet per second per acre.

S = slope of water-shed in feet per 1,000 feet.

A = area of water-shed in acres.

The amount of sewage to be carried off has been assumed to equal 150 Imperial gallons per day per person, half of this quantity reaching the sewers in eight hours. The average density of population in the territory to be provided for has been assumed at 50 persons per acre.

In cases where it is not objectionable to allow the street water to enter natural water courses, it is also generally not objectionable to allow the overflow from sewers, taking place during heavy storms, to enter them. In order to economize in the size of the sewers, it is therefore proper to make use of any opportunity that may offer for an overflow at points where it cannot be objected to.

There are two water courses in your city: the Rideau canal and the Rideau river. It is not permissible, I am informed, to allow any sewers to overflow into the Rideau canal. But there can be no objection, with certain limitations, to an overflow into the Rideau river, which has sufficient water to receive an occasional discharge of highly

diluted sewage, without causing any offence or improper results ; such an overflow will not carry with it sediment of a nature to deposit in the river and fill up the channel. It will take place only during heavy rain-falls and always in advance of an increased discharge of the river itself, resulting from the same rain-fall, which would prevent deposit and carry any diluted sewage away.

Some of the present main sewers are found to be of insufficient size. The sewer on Florence and Waverly streets which finally unites with the Slater street sewer, now discharges into the main sewer east of the canal, which thereby becomes overcharged. To obviate this trouble it has been proposed to intercept the storm water of the former and discharge it into the main sewer proposed for the undrained portions of the western part of the city. In this way the present sewers can regain their former usefulness.

After these preliminary remarks, it is now in place to examine certain general projects for collecting the sewage from the undrained territory.

One proposition, the one originally presented by your City Engineer, is to retain the present sewage discharge at the water works tail-race (marked on the plan as Outfall "B") and allow whatever sewage and rain-water may naturally go there by gravity, to be permanently discharged at such point.

The rest of the territory, lying to the east of a ridge which divides the city, roughly speaking, near the line of Bell street, is provided for by a main sewer going to the eastward, crossing the Rideau canal, reaching the Rideau river and following its western bank as far as St. Patrick street, where it crosses to Porter's Island and finally takes the eastern side of the river down to an outfall at the foot of John street. (Out-fall "D.")

This proposed sewer is to intercept the storm-water from the

present Florence and Waverly street sewer at the intersection of Charles and Cartier streets, but it allows for a storm-water overflow at the foot of Somerset street, where it first reaches the Rideau river.

A recalculation of this project has been made, on the basis of providing for the same amount of storm water that was suggested for the plan presented by Messrs. Keefer and Davy. This was done for the purpose of making a fair comparison between the two plans.

It has been remarked in your city that the two main advantages of this project would be a discharge of most of the city's sewage below the mouth of the Rideau river and therefore below the principal part of the city, and that there would be a more natural alignment through the city, in view of the fact that the ridge near Bell street forms the dividing line between the two main districts.

With reference to the first claim, I must refer to my previous remarks upon the disposal question, and conclude that there is no specific advantage in the location of the outfall proposed for this sewer. The second claim must be decided on the score of economy. I have therefore compared this system with the others solely on a basis of cost.

A second proposition is the plan which has been presented by Messrs. Keefer & Davy. It also contemplates the division of the city into two parts, but makes the Rideau canal the dividing line.

The western part of the city is to be provided with a new main sewer, relieving the present main sewer of its storm water at Charles and Cartier streets, and then extending westerly on or near the line of Isabella street to Preston street, and thence to a proposed outfall ("B") into the tail-race below the water works pumping station The main sewer would require to be in tunnel through the ridge near Bell street.

The eastern part of the city is to be provided for by a main sewer starting on Templeton street and reaching the Rideau river on Somerset near Riverside avenue, where a storm-water overflow is to be provided,

and then following virtually the same line to the same outfall ("D") previously mentioned, at the foot of John street east of the mouth of the Rideau river.

A third proposition contemplates an eastern outfall at a point projecting into the river about 2,000 feet below the John street outfall, and marked Outfall "E" on the plan. The collection of the sewage can be made as suggested either in the first or the second propositions.

A fourth proposition has since been made contemplating an eastern outfall below Rockliffe (Outfall "F"). The collecting sewers are the same as in the former cases, except that at St. Patrick street bridge the sewage is carried eastward to the Rockliffe outfall which is near the mouth of the stream flowing out of McKay's lake. The alignment for this outfall sewer below the Rideau river, as surveyed by your City authorities, might, on closer investigation, possibly be shortened and otherwised improved.

A fifth plan, otherwise virtually the same as the second, has the sewage outfall for the undrained portion of the Western District removed from the water works tail-race and placed in the channel of the Ottawa river above the mouth of Buchanan channel, at a point designated Outfall "A." Where the proposed western main sewer crosses Bridge street, it would be intercepted by a 24 inch pipe, which would carry the sewage to this outfall. When Crossing Ottawa street it would also intercept the sewage of the present sewer and discharge it at the same outfall. The storm water would continue its course and discharge into the tail-race below the water works. The outfall for the Eastern District wauld be at the foot of John street,

Finally, a sixth plan has been considered, which excludes all sewage from the tail-race and therefore prevents any sewage discharge into the river above the present outfall near McLaren's Mills, marked "C," and which allows only a small amount of sewage to go into the Ottawa river at the two present outfalls near the mouth of the Rideau

river. In short, nearly all of the sewage would be intercepted and carried to the Rockcliffe outfall "F." For this purpose a sewage pumping station would be located near the present water works. The sewage of the entire Western District, present and proposed, would be pumped at this point into the upper end of the present Slater street sewer at Bay street. In this sewer it would run by gravity as far as St. Patrick street, thence by a new intercepting sewer on this street to the bridge crossing the Rideau river and continue to the Rockcliffe outfall.

The sewage could of course discharge at McLaren's mills, instead of at Rockliffe, if the expense of the latter route were objected to. When the Slater street sewer becomes surcharged, then a special sewer could be laid on the same or on an adjoining street to receive the sewage that has been pumped. If laid on another street it could be made larger and provide also for the storm water removal on that street.

At first it would require pumps with about 30 h. p. to lift the sewage. After the present undrained districts are entirely built up and have a population as dense as in the present well built-up sections of the city it would require pumps with 150 h.p.

This proposition could be carried out by collecting the sewage either as suggested in the first or second plans.

All of the above-mentioned plans are feasible and would give perfect satisfaction in their results. Preference should be based on the question of cost, into which we shall now examine.

III.

ESTIMATES OF COST AND CONCLUSIONS.

As a preliminary, it is necessary to compare the cost of collecting the sewage according to the first plan, which divides the drainage areas near Bell street, and by the second plan, which divides them at the Rideau canal.

The fact that no overflow into the Rideau canal will be permitted, makes it necessary in the first plan to carry all the storm water west of the canal and east of the ridge near Bell street through the eastern district as far as the Rideau river, before such an overflow is practicable permissible. Thus a sewer of such large dimensions would be required that its cost is excessive.

A glance at the map will explain this fact. Theoratically speaking, when two sewers start at about the centre of a territory and run in opposite direction, then each will drain about half of the whole territory. But when one of these sewers, in addition to draining one half must be large enough to receive and carry off also the water from the other half, then it must have double the capacity.

While this conclusion is evident by itself, it has been further demonstrated by an estimate of cost with the result that the first plan of sewage collection would cost about $33,628 more than the second. In arriving at this figure it is assumed of course that both plans provide for carrying off an equal proportion of the rain-fall, for a discharge of the sewage into the water works tail-race, and for an over flow, during heavy storms into the Rideau river.

The excessive cost, thus obtained, is not due to the use of the combined system. The same result would appear if the separate system were used, for the conclusion is based on the condition that not only sewage must be kept out of the Rideau canal, but also most of the storm water. The street washings would carry silt and dirt into the canal, which, while not objectionable in a running stream, would be so in the level stretches of a canal.

The first plan should therefore be rejected on the score of economy, and I am obliged to approve in general of the method of alignment adopted by Messrs. Keefer & Davy, dividing the territory by the canal into an eastern and western district.

After having reached this conclusion it is necessary to again take

up the outfall question and from among the locations previously mentioned determine the most suitable one for the general method of collection just approved.

Among those outfalls which I have considered equally good from a sanitary point of view, preference, in my opinion, should be given to the project costing the least.

The following summary of the estimates of cost shows the total cost of each project in such a manner that a fair comparison can be made.

SUMMARY OF ESTIMATES OF COST.

Recommended Plan.—Discharging only sewage at Outfall "A," only storm water at Outfall "B" and sewage and storm water at Outfall "D."

Western Sewage Interceptor, Outfall "A"		$ 18,423
Western Main Sewer, Outfall "B"		220,006
Eastern Main Sewer, Outfall "D"		148,171
		$386,600
Bank street Relief Sewer	$10,396	
Isabella street Relief Sewer	34,019	
		44,415
		$431,015

Alternate Plan I.—Discharging sewage at Outfall "A", storm water at Outfall "B" and sewage and storm water at Outfall "E."

Western Sewage Interceptor, Outfall "A"		$ 18,423
Western Main Sewer, Outfall "B"		220,006
Eastern Main Sewer, Outfall "E"		172,186
		$410,615
Bank street Relief Sewer	$10,396	
Isabella street Relief Sewer	34,019	
		44,415
		$455,030

Alternate Plan II.—Discharging sewage at Outfall "A," storm water at Outfall "B," and sewage and storm water at Outfall "F."

Western Sewage Interceptor, Outfall "A"	$ 18,423
Western Main Sewer, Outfall "A"	220,006
Eastern Main Sewer, Outfall "F"	179,606
	$418,035
Relief sewers, as before	44,415
	$462,450

Alternate Plan III.—Discharging storm water at Outfall "B" and sewage and storm water at Outfalls "C" and "D,"

Western Main Sewer, Outfall "B"	$220,006
Pumping Machinery, etc	22,500
Force Main and Special Sewer on Slater street	26,548
Eastern Main Sewer, Outfall "D"	148,171
	$417,225
Relief Sewers, as before	44,415
	$461,640

N. B.—No estimate of the annual cost of pumping is given.

Alternate Plan IV.—Discharging storm water at Outfall "B" and into Rideau River and nearly all the sewage at Outfall "F."

Western Main Sewer to Outfall "B"	$220,006
Pumping Machinery, &c	22,500
Force main and Special Sewer on Slater street	26,548
Sewage Interceptor on St. Patrick street	26,415
Eastern Main Sewer to Outfall "F"	158,253
	$453,722
Relief sewers, as before	44,415
	$498,137

N. B.—No estimate of the annual cost of pumping is given.

The least expensive plan is that which discharges the sewage from the Western district into the river current above the Buchanan channel and from the Eastern district into the river current off the foot of John street. For this reason and because it will give as good practical results as any of the others, it is the plan which I can recommend to you.

The next project in the order of cost, designated as Alternate Plan I, leaves the Western district treated as before, but removes the outfall for the Eastern district to a point "E" further down the river. I can see no practical advantage in this removal as, in either case, the sewage is equally soon dispersed and disappears from sight.

The next project in the order of cost, designated as Alternate Plan II, again leaves the Western district as before, but the Eastern district has its outfall below Rockliffe. This project costs $31,435 more than the recommended plan, while the final disposal of the sewage is not any more efficient, but the place of outfall is merely removed to below the city.

Finally, the projects designated as Alternate Plans III and IV, are the most expensive but have a certain sentimental value. They have for their object the interception of the city's sewage and the discharge of most of it either at the mouth of the Rideau river, as in Plan III, or at Rockliffe, below the city, as in Plan IV. The cost of these two plans is respectively $30,625 and $67,122 more than the recommended plan besides the annual cost of pumping, for which no estimate is given. If this annual cost is added to the interest on the outlay for the construction of the works (III or IV), it makes either of the pumping projects much more expensive than any of the others.

In conclusion, it may be well to refer to a few of the detailed features of the project which is recommended and which is indicated on the accompanying map and profile.

The alignment is shown on the plan in full red lines and varies but slightly from the Keefer and Davy plan. The most important of

these variations is the manner of relieving the existing sewer on Florence and Waverly streets, which is accomplished at two points instead of at one point. This was done for economical reasons as the total cost thus becomes less. The excess of water on Florence street is taken off at Bank street, instead of after it has had a roundabout course to Cartier street, and the size of the sewer on the latter street is reduced. A sewer also for local purposes is thereby provided on a part of Bank street.

Dotted red lines show the streets where tributary interceptors and branch sewers should be located, when required.

The principal tributary sewers are : One extending from the main sewer at Isabella and O'Connor streets to Centre and Bank streets, passing under Patterson's Creek ; and the other extending out Preston street passing along the east side of Dow's Lake, and to the intersection of Centre and Gordon streets.

There should be a storm water overflow at the eastern end of Somerset street where the main sewer reaches the Rideau river, as the river is sufficiently large to provide a good dilution. To make sure that no trouble will arise it has been assumed that this overflow will not act until the sewage is diluted twenty times. The overflow opening must be protected by a flap valve, so that the river water during high stages does not enter the sewer.

The Rideau river can be crossed at St. Patrick street without depressing the sewer. If the river bed is lowered, as has been proposed, then the sewer must cross as an inverted siphon, in the shape of two 30 inch steel pipes, laid in a trench on the bottom and surrounded with concrete.

The present sewer on River Lane would be replaced by the proposed sewer between the corner of Charles and John streets and the Ottawa river.

The alignments not only of the main trunk system, but also of the

auxiliary sewers have been carefully considered with reference to good service and economy.

It may be remarked at this place that in the future the present sewer on Slater street will require a relief from storm water surcharge. This can be arranged by an overflow drain on Bank street or O'Connor street to the Ottawa river ; by another from the corner of Musgrove and George streets to Nepean Point ; and still another from the corner of Cathcart and King streets to the Rideau river.

The city area is divided by special tints so as to bring out clearly the areas now drained, those to be relieved, those to be drained by the proposed sewers, and those from which the surface water shall continue to run, as now, into the adjoining water courses.

The profile, which accompanies the plan, indicates the depth of the main sewers and will otherwise explain itself. The rock excavation has been determined from the results of borings furnished me. Where such were not available assumptions had to be made. It goes without saying that the quantity of rock to be excavated materially affects the cost.

On Templeton and Nelson streets it will be necessary to raise the street surface, so as to provide sufficient covering for the sewer. This expedient will cost less than lowering the sewer for its entire length. It also raises the level of the overflow at the river, which is an advantage both in economy and efficiency.

In proportioning the sizes of the main sewers I have excluded the storm water from areas close to the Rideau canal and river, as it can be permitted to enter these water courses without detriment. Of the entire undrained territory the storm water from about 300 acres has been thus excluded from the sewers and permitted them to be of smaller sizes.

The two main sewers above described can be thoroughly flushed by water from the Rideau canal at times when there is a surplus of water available. The eastern main sewer may also be flushed with water from the Rideau River.

The estimates of cost are believed to be ample in each case to carry out the work, excepting that they do not include the cost of

rights of way. They have been based upon information received at Ottawa as to prices of material and labor, and as to the character of the soil and rock expected to be found.

It has been assumed that the sewers are built of brick, with proper care they could with advantage be built of concrete and the 24 inch sewers of pipe, and the cost thereby reduced. In deep rock cuts the sewers were estimated to have an egg shape to save width of cutting All others were assumed to be circular. No allowance was made in the estimates for street water inlets, catch basins, or private sewers to the curb lines.

In order to cover some doubtful features, particularly as to rock excavation, I have added 15 per cent. of the total amounts as a fund for contingencies.

Mr. E. H. Keating's advice, to establish automatic rain gauges in your city, I can heartily endorse. The results to be gained therefrom will be of great economic value at a future time when the city is more densely built up. It will then be necessary to build relief sewers or drains to carry the excessive storm water to the rivers and a record of the intensity of the heaviest storms and of their frequency will enable the dimensions to be accurately determined.

A sewerage system, to be economical and to give perfect satisfaction in its operation, must have great attention given to the proper design of the numerous details. Most of the trouble that usually occurs arises from a neglect in this respect.

In the Appendix will be found:

I. Detailed estimates of cost.

II. Table, showing location, Sizes, Slopes, &c,, of Main Sewers.

III. Table, showing depth of Inverts of Sewers below the surface at various points on the lines of the Main and Relief Sewers.

Very Respectfully,

RUDOLPH HERING.